4.7 NOISE

4.7.1 Impacts of the Proposed Master Plan

Construction

During construction, there would be a temporary increase in sound levels along access roads to the site and near on-site construction areas due to the use of heavy equipment and the hauling of construction materials. The increase in noise levels would depend on the type of equipment being used, and the amount of time it is in use. **Table 4.7-1** displays ranges of noise produced by typical construction equipment.

Table 4.7-1
TYPICAL CONSTRUCTION EQUIPMENT NOISE (DBA)

Activity	Range of Hourly Leqs		
	At 50 ft	**At 100 ft**	**At 200 ft**
Clearing	83	77	71
Grading	75-88	69-82	63-76
Paving	72-88	66-82	60-76
Erection	72-84	66-78	60-72
Types of Equipment	**Range of Noise Levels**		
	At 50 ft	**At 100 ft**	**At 200 ft**
Bulldozer	77-96	71-90	65-84
Dump Truck	82-94	76-88	70-82
Scraper	80-93	74-87	68-81
Paver	86-88	80-82	74-76
Crane	75-85	69-79	63-73
Generators	71-82	65-76	59-70
Compressors	74-81	68-75	62-69

Source: EPA, 1971, modified by MFG, Inc., 2003

As shown in Table 4.7-1, sound levels 200 feet from construction equipment exceed the levels generally recommended for residential land uses. Parts of the proposed project would require construction activities very close (< 50 feet) to some existing residences, so at some times sound levels would very likely exceed the maximum permissible levels shown in the upper portion of Table 3.7-2. Construction noise received on off-site properties is subject to King County noise limits listed in the lower portion of Table 3.7-2 (see Section 3.7), which are substantially higher than the “base”

maximum permissible levels. Because most construction would take place at locations greater than 50 or even 100 feet from residential receivers, such noise would be able to comply with the construction noise limits most of the time. In instances where construction would have to occur near to sensitive receivers (i.e., homes or schools), noise control measures may be necessary to insure compliance with King County noise limits and to avoid or minimize noise impacts.

Construction of Greenbridge would occur in 3 stages. Demolition and construction would begin at the west end of the project area and move east. Construction noise would be a concern for existing on-site and nearby off-site residential receivers during both the demolition and construction of the various phases of the project. Construction noise within 100 feet of residential receivers could create levels near or above the limits listed in Table 3.7-2, and such levels could impact on-site and off-site residential uses. While noise from construction of the project received at on- site homes is not technically subject to the County noise limits (because the sources and receivers are on the same property), noise impacts may nonetheless occur unless noise is controlled during periods when construction must occur close to sensitive uses. Construction noise received at off-site locations is subject to the County noise limits. Mitigation measures are described below to address construction noise.

Operation

Two primary types of noise impacts are relevant to the Greenbridge proposal and are addressed in the following analysis: noise generated by the proposal itself, such as that from traffic or new uses; and the existing noise environment of the site, which is the context in which the project would be evaluated according to HUD's noise criteria.

The Proposed Master Plan would increase noise in the vicinity of the project site by generating additional traffic and by potentially creating new noise sources on the project site (such as HVAC equipment on top of proposed commercial buildings). The primary noise source associated with the project would be traffic. The new development pattern could also lead to either redistribution of noise-generating activities on the site, or construction of new noise-generating uses (such as HVAC units on top commercial buildings). The Proposed Master Plan and the Design Alternative Master Plan would generate similar additional traffic volumes and increases in residential and non-residential uses, and therefore result in nearly identical noise levels. Consequently, the following discussion identifies potential impacts as a result of either alternative.

Increases in Off-Site Traffic

Increased residential and non-residential development on the project site would result in increases in traffic on nearby off-site roadways. These increases in traffic volumes could increase traffic noise levels at off-site receivers adjacent to the affected roadways. SW Roxbury Street and SW 100th Street would experience the largest increases in traffic volumes as a direct result of the proposed project. Although traffic volume increases can be expected beyond these roadways, any sound level increases at more distant locations would be minor in comparison.

King County noise limits are not applicable to traffic, and FHWA/WSDOT criteria do not apply to traffic related to Greenbridge because no state routes are involved. These limits, however, provide an indication of the relative significance of anticipated sound levels. Because both the King County and FHWA/WSDOT limits are based on an hourly standard, calculated hourly Leqs due to traffic sources can be compared with the levels suggested by these code requirements. Because no

modifications to off-site roadways are proposed as part of this project, calculations were used in the initial assessment of the relative increases in traffic noise over existing levels. In general, a doubling of traffic (a line source) would produce a 3-dBA increase in sound levels, provided the physical relationship between the source and receiver, the speed, and traffic composition do not change.

Two off-site locations were examined in the initial analysis: along SW 100th Street, and along SW Roxbury Street (see Appendix I of this Draft EIS). These areas represent nearby off-site locations where the greatest increases in traffic due to the proposed project are expected. Calculations were performed to determine increases in traffic noise above existing levels and also above 2012 Baseline No Action sound levels (please refer to the discussion of Baseline/No Action traffic in the *Transportation* section of this Draft EIS). The calculations assume no change in the composition of traffic (i.e., percentage of cars, trucks, motorcycles, buses, etc) or the average travel speed, and that the off-site roadways will not be modified.

Table 4.7-2 below shows the results of the off-site sound level calculations. Along SW Roxbury Street, traffic volumes under the No Action Alternative would increase by approximately 11 percent over existing volumes and would increase traffic noise about 1 dBA over existing conditions. Under the Proposed Master Plan, traffic volumes on SW Roxbury Street, west of 8th Avenue SW, are expected to increase by approximately 3.7 percent over future No-Action traffic volumes. Traffic noise would not increase relative to existing sound levels or No Action. These small increases in traffic noise would likely not be noticed at nearby residential receivers.

Existing afternoon peak-hour noise levels along SW Roxbury Street are, however, are currently above what King County, WSDOT or the City of Seattle would consider acceptable for residential areas – although not subject to these jurisdictions' requirements – and would remain above these levels with or without the proposed development. Receivers north of SW Roxbury Street near the project site are in the City of Seattle. Traffic noise exceeds the levels generally considered acceptable for residential uses, but noise from traffic on public roads is exempt from the Seattle noise limits.

Along SW 100th Street, the No Action Alternative would increase traffic by 30 percent along SW 100th Street, and the Proposed Master Plan would increase traffic by 79 percent (63 percent for the Design Alternative Master Plan) over existing traffic volumes. Traffic volumes counted during the sound level measurement closely matched the existing afternoon peak-hour volumes provided by The Transpo Group, so the afternoon peak-hour sound level would be nearly identical to the sound levels measured at noon.

Calculations indicate the No Action Alternative would increase traffic noise along SW 100th Street about 1 dBA over existing conditions. The Proposed Master Plan would increase traffic noise by 2 dBA over existing levels (3 dBA for the Design Alternative Master Plan). These small increases in traffic noise would likely not be noticed at nearby residential receivers.

Because the sound measurement and initial calculations indicated there are and would continue to be high on-site sound levels near SW Roxbury Street, several additional sound level measurements were taken, and additional calculations performed to examine future sound levels near this road. The primary purpose of this additional analysis was to examine the need for and potential effectiveness of possible mitigation measures. This aspect of the noise review is discussed more completely in the section on site suitability.

Table 4.7-2
PREDICTED OFF-SITE TRAFFIC NOISE LEVELS

Location	Calculated Peak-hour Leq Sound Levels (dBA)			
	Existing	No Action	Proposed Master Plan	Design Alternative Master Plan
SLM 1 Near north border of site; SW Roxbury Street	68	68	68	68
SLM 4 Near south border of site; SW 100th Street	57	58	59	59

Future traffic noise levels are forecast for SLM locations 1 and 4 because these locations are both dominated by traffic noise from major roads. The on-site location at which SLMs 2 and 3 were taken is not considered because it is farther removed from any roads and so not dominated by traffic noise. SLM locations area described in Appendix I and shown on **Figure 4.7.1**.

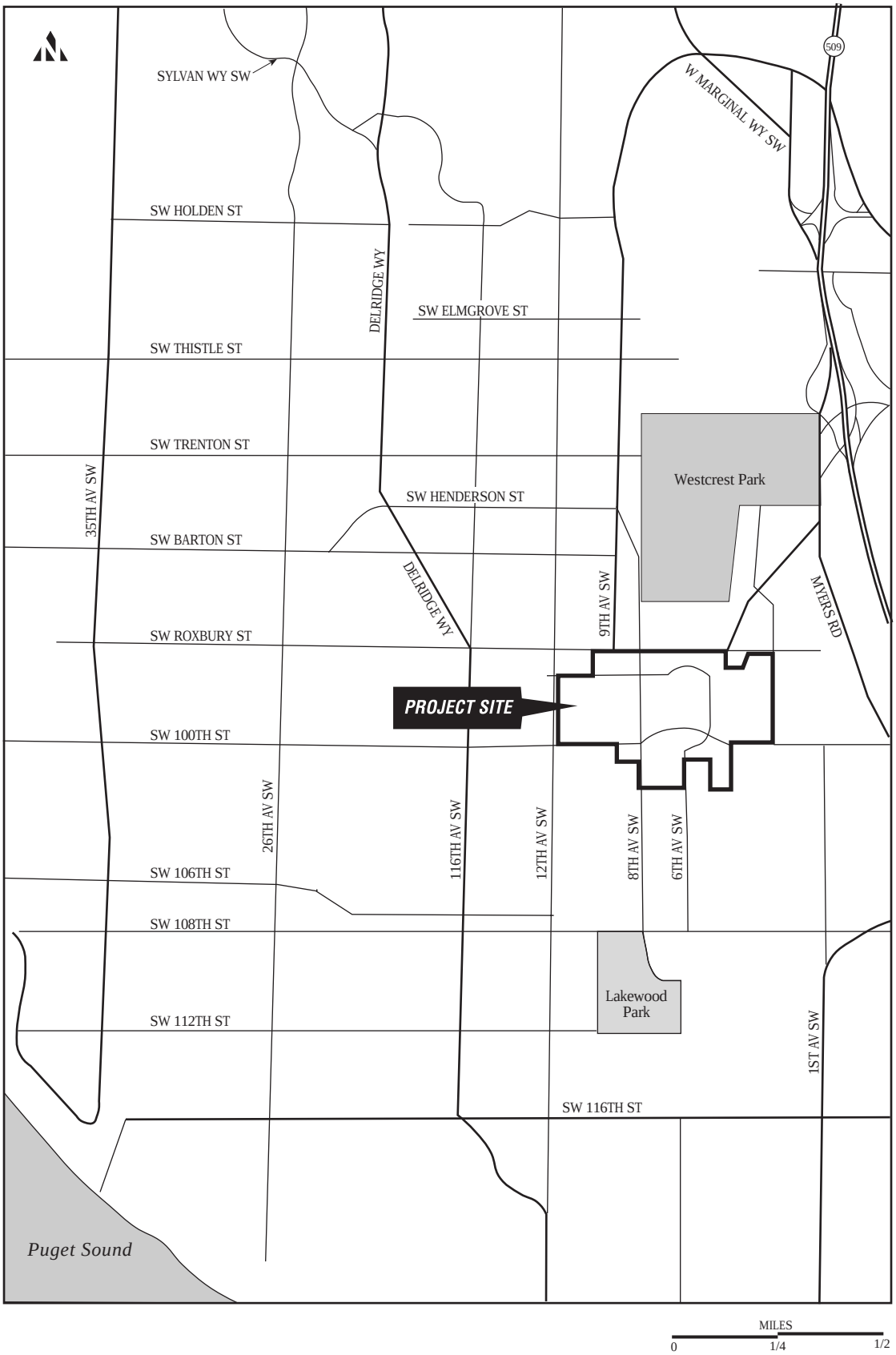
Source: MFG. Inc. 2003

Non-Traffic Sources of Noise

Redevelopment within the project site would include education and recreation facilities, many of which already exist on-site. Minor commercial uses are also proposed for the site. Truck loading docks, rooftop heating, ventilation and air conditioning (HVAC) units, or other equipment that could potentially generate significant noise would be subject to King County's established sound level limits for such sources affecting residential receivers. These sources could cause impacts at nearby homes if there is no effort to limit or reduce noise. However, based on typical operational impacts for the type of facilities identified in the Proposed Master Plan, it is not expected that noise levels would exceed limits established by King County.

Site Suitability

In addition to assessing noise associated with the proposed development, HUD's regulations require assessment of noise conditions for overall sound levels in the vicinity of any project using HUD funding. Proposed residential uses on the project site, therefore, are subject to HUD's noise suitability criteria (Table 3.7-3 in Section 3.7). These limits are based on overall sound levels, regardless of the sources and regardless of whether an existing condition or caused by the project. The baseline 24-hour sound level measurement taken on the site documented the existing noise environment at the time of that measurement. The measurement location was selected based on its potential to receive noise from a major off-site source. On-site noise was also measured at other locations with two 15-minute measurements taken in conjunction with the long-term measurement, with which they were compared. The only significant source of off-site noise is traffic along SW Roxbury Street; no major on-site sources have been identified. The implications of this noise source to existing and expected future levels on the project site are discussed below.



Huckell/Weinman Associates, Inc.
HWA

HOPE VI
GREENBRIDGE
REVITALIZATION PROJECT

Figure 2.1-2

Vicinity Map

Additional short-term sound level measurements were taken on the project site after the initial analysis indicated current and future sound levels near SW Roxbury Street currently do and would continue to exceed HUD suitability noise limits. These measurements are discussed further in the next section.

Off-Site Sources of Noise Affecting the Project Site

The noise environment at residential locations on the project site adjacent to SW Roxbury Street was documented by SLM 1 (see Table 4.7-3 and Appendix I for details). The measured L_{dn} at this location was 71 dBA. Although 2012 traffic volumes are expected to increase along SW Roxbury Street, the increase in traffic volumes is relatively small, and the resulting 2012 L_{dn} would remain unchanged from existing levels. Day-night sound levels above 65 dBA are considered "normally unacceptable" by HUD, and levels above 75 dBA are considered "unacceptable" (see Table 3.7-3 in Section 3.7). According to HUD standards, environmental review (i.e., this EIS) and additional attenuation are required (24 CFR 51.103). In addition, 51.105 provides an exception to the 65 dBA limit if certain criteria are met.

With the proposed project, many first-row receivers[1] adjacent to SW Roxbury Street would likely be within about 75 feet of the centerline of the road (similar to the existing residences), and outdoor use areas even closer. Future traffic noise levels at these receivers were examined further using the noise modeling explained below.

Sound level measurements taken further south of SW Roxbury Street indicate that second-row receivers (those located behind first-row receivers, away from the traffic source) would experience traffic noise levels considered “acceptable” by HUD (below 65 dBA). The shielding effect of the homes nearest SW Roxbury Street, in addition to distance attenuation of traffic noise, appears sufficient to reduce traffic noise at locations south of first row receivers. An estimate of the 24-hour L_{dn} at the SLM 2 and SLM 3 location is approximately 60 dBA, acceptable by HUD standards.[2] No other roadways, including SW 100th Street, are expected to exceed HUD suitability criteria for the proposed project.

A more detailed analysis of future noise levels at residential receiving locations on the project site south of SW Roxbury Street was conducted, and included additional short-term sound level measurements (SLMs) on the project site, and noise modeling using the FHWA Traffic Noise Model (TNM, v. 2.1 FHWA, 2003). Supplemental SLMs and field observations were performed in September 2003 to provide additional information necessary for the noise modeling. These measurements, taken during the afternoon hours, were consistent with the earlier, long-term SLM on the site. These measurements were used in the setup of the TNM tool, which is a state-of-the-art noise model specifically designed to consider traffic noise sources and to evaluate the noise-reducing effects of noise barriers. This model considers traffic volumes, composition, travel speed, intervening terrain and ground types, and the presence or absence of obstructions like buildings or noise barriers to calculate hourly L_{eqs} from traffic sources.

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1 First row receivers are those closest to the affecting roadway without intervening structures or large and densely wooded area that could interrupt the transmission of noise from a road to a receiver.

2 This estimate of the second-row Ldn was calculated by comparing SLM 2 and SLM 3 measurement results with SLM 1. The difference between SLM 2 and SLM 3, compared with SLM 1, was -12 and -15 dBA, respectively. Calculating the Ldn by subtracting 12 dBA from each hour of the long-term measurement (SLM 1), and then performing an Ldn computation with these reduced hourly Leqs, is therefore considered a conservative estimate of the second-row Ldn. This is only an estimate.

Calculated sound levels at the supplemental measurement locations were within 2 dBA of the measured sound levels at these same locations, indicating the modeling is accurately representing the road and the site terrain in the area. The calculated future on-site noise levels at residential receivers near SW Roxbury Street are shown in **Table 4.7-3**.

Table 4.7-3

2012 TNM-CALCULATED ON-SITE TRAFFIC NOISE LEVELS (L_{DN} - dBA)

Receptor Location	Day-Night Sound Level Ground-Level Receptors	Day-Night Sound Level Elevated Receptors
West of 8th Avenue SW – Outdoor Use Area	74 – 75	
West of 8th Avenue SW – Building Location	72 – 75	74 – 75
Between 8th and about 7th Avenues - Building Setback	74 – 74	74 – 75
Between About 7th and about 8th Avenues Building Setback	66 – 71	71 – 73
Between about 8th and 5th Avenues – Potential Outdoor Use Area	73 – 74	
Between about 8th and 5th Avenues – Building Setback	71 – 73	69 – 70

Notes:

- All locations are on the project site, south of SW Roxbury Street
- These findings are presented as ranges because they summarize modeling results for a number of modeling receptor locations in each of the four sections of the northern portion of the project site
- The two shaded cells do not contain data because there are no elevated receivers at these locations
- Levels are estimates derived from TNM calculated peak-hours sound levels, adjusted to represent the day-night sound level based on a nearby 24-hour sound level measurement
- Ground level = ground elevation plus 5 feet; elevated = third-story height

Source: MFG, Inc. 2003

Private outdoor use areas associated with residential units would be located adjacent to SW Roxbury between the residential units and the roadway. Two parks are also proposed adjacent to SW Roxbury. Users of these areas would be exposed to "normally unacceptable" noise levels, based on HUD criteria, created by traffic along SW Roxbury Street. Sound levels at buildings abutting this street also currently exceed the HUD noise criteria and would continue to exceed these criteria in the future with the Proposed Action, the Design Alternative or No Action.

4.7.2 Impacts of the Alternatives

Design Alternative Master Plan

Noise impacts would be similar to the Proposed Master Plan and are discussed above.

No Action Alternative

The No Action Alternative would result in no significant increase in traffic noise, construction noise or other noise source impacts at existing residences. As noted previously, existing traffic noise

levels exceed HUD noise criteria. Off-site traffic noise levels were computed to provide a comparison with traffic noise associated with the action alternatives. Exterior noise levels (at SLM1) would be the same as the Proposed Master Plan, as shown in Table 4.73. Details of the methods used and sound level increases are outlined below in the discussion of the two Action Alternatives.

4.7.3 Mitigation Measures

Construction

Some relatively simple and inexpensive practices can reduce the extent to which people are affected by construction noise. Examples include using properly sized and maintained mufflers, engine intake silencers, engine enclosures, turning off idle equipment, and confining activities to daytime hours. Construction contracts can specify that mufflers be in good working order and that engine enclosures be used on equipment when the engine is the dominant source of noise.

Stationary equipment could be placed as far away from sensitive receiving locations as possible. Where this is infeasible, or where noise impacts are still significant, portable noise barriers could be placed around the equipment with the opening directed away from the sensitive receiving property. These measures are especially effective for engines used in pumps, compressors, welding machines, and similar equipment that operate continuously and contribute to high, steady background noise levels. In addition to providing about a 10-dBA reduction in equivalent sound levels, the portable barriers demonstrate to the public the contractor's commitment to minimizing noise impacts during construction.

Substituting hydraulic or electric models for impact tools such as jack hammers, rock drills and pavement breakers could also reduce construction and demolition noise. Although back-up alarms are exempt from the noise ordinances, noises from such devices are among the most annoying sounds from a construction site. Where feasible, equipment operators could drive forward rather than backward to minimize this noise. Noise from material handling could also be minimized by requiring operators to lift rather than drag materials wherever feasible.

Where possible, contractors should make efforts to keep construction equipment greater than 100 feet from or to shield the nearest on and off-site residences and the school to comply with County construction noise limits and to minimize impacts to these sensitive receivers. Although the overall construction sound levels will vary with the type of equipment used, common sense methods of noise attenuation should be applied.

Operation

The proposed project would not result in any on-site operations that would be expected to cause significant amounts of noise and significant operational impacts are not expected; mitigation of project-generated noise is neither warranted nor proposed.

However, some form(s) of noise mitigation will be required to reduce noise from traffic on SW Roxbury Street so that day-night sound levels at outdoor use locations and inside residences on the project site would be within the levels considered “acceptable” by HUD or would otherwise meet HUD requirements for attenuation. The initial analyses were performed to examine both the potential effectiveness of noise barriers and to more completely delineate the portions of the project site where such mitigation could be appropriate. The methods and the findings of this mitigation

analysis are presented below, following a more general discussion of the purposes of such measures and the types of mitigation available.

HUD noise limits are intended to provide suitable acoustic environments in both outdoor use areas "where it is determined that quiet outdoor space is required in an area ancillary to the principal use on the site," and in interior residential spaces (24 CFR 51.103(c)). The goal for interior sound levels is a day-night sound level of 45 dBA (HUD 1985). Potential means for controlling on-site noise levels in order to meet these requirements are outlined below.

In discussing approaches to mitigation when exterior sound level have been found to be too high, HUD guidance can be summarized as follows (paraphrased from HUD 1985.) . There are three basic ways to provide the noise attenuation required: noise barriers, site design modifications, or acoustical construction. Of these, only the first two can improve sound levels in both exterior and interior environments. Because HUD considers a quiet environment to be important, measures that reduce both exterior and interior levels are preferred. The use of acoustical construction by itself is least preferred because this approach only affects interior levels. While it is recognized that in many cases noise barriers or site design cannot provide all the attenuation necessary, these methods should be combined with acoustical construction whenever possible. The following sections discuss these concepts more completely and then present the results of the analysis that investigated means to mitigate on-site noise levels.

Noise Walls

Noise walls or berms could be designed to reduce traffic noise from SW Roxbury Street both at adjacent receivers and at receivers farther from the road. Some portions of the northern site boundary appear to present an opportunity to implement effective noise barriers, since the terrain is mostly level or above the grade of SW Roxbury Street, and there are long stretches that could accommodate continuous barriers. Because of the several "breaks" that would be required for intersecting roadways, not all potentially affected residences would benefit from barriers. However, barriers could be "wrapped" slightly near intersecting roadways to improve their effectiveness. With effective noise barriers, it is likely that HUD acceptability criteria could be met in some of the residential use locations where noise levels would otherwise be considered "normally unacceptable" by HUD.

However, noise walls would create conflicts with Greenbridge master plan and HOPE VI program goals, with security and maintenance of the site, and with other environmental values (i.e., aesthetics).

- Walls along the perimeter of the site would create substantial physical, psychological and social barriers which could reinforce the historical separation of the site from the surrounding community. Such a result would conflict with the explicit goals of the HOPE VI program and the Greenbridge master plan to achieve physical and social integration.

- Walls would create security issues by blocking views between the site and the street. Blocking the community's "eyes on the street" could compromise residents' sense of safety. Walls would also create places to hide.

- The two small parks located adjacent to SW Roxbury Street are not designed or intended to be places for contemplation or activities requiring a quiet environment. Other parks and

open space areas located in the interior of the site, away from background traffic noise, would provide such opportunities. Noise walls along SW Roxbury Street would, therefore, not achieve a level of quiet in the two affected parks that would result in a change in their intended functions.

- Even the most well-designed noise walls are not commonly perceived to be attractive. The location of walls along SE Roxbury Street would present a strong visual image to the neighborhood, one that would conflict with the aesthetic values incorporated in Greenbridge's design. In urban areas, solid walls are also frequent targets of graffiti; such vandalism could create an ongoing eyesore and/or maintenance burden for the Housing Authority.

Because of these numerous conflicts, it is appropriate to consider balancing achievement of the noise criteria with other planning, environmental and social goals, as permitted by HUD's noise rules (24 CFR 51.105).

Mitigation Analysis Findings

The TNM modeling tool was used to examine the potential effectiveness of four noise barriers to shield proposed residential buildings and several outdoor use areas that front on SW Roxbury Street. The northern portion of the site was subdivided into four sections to simplify the analysis. The four areas considered were generally indicated previously in Table 4.7-3, and are discussed further below. To aid in this analysis, standard barrier effectiveness criteria developed by the Washington State Department of Transportation (WSDOT) were employed to assess whether each noise barrier would be considered both effective in reducing noise and cost-effective. Note that WSDOT noise criteria do *not* apply to this project; they are used only to provide perspective on this mitigation approach.

The noise mitigation analysis considered four locations in the northern portion of the project site adjacent to SW Roxbury Street as shown on Figure 4.7-1: the west end (west of 8th Avenue), the center block (near the proposed multi-story multi-family building just east of 8th Avenue), the center hill (east of 7th Avenue to west of 6th Avenue), and the east end (between about 6th Avenue and 4th Avenue). In each area, model receptors (i.e., theoretical locations used in the modeling to represent buildings or other uses/ areas of interest) were placed as follows: at ground level between the proposed building locations and the street, at ground level and at elevated (i.e., 2nd and 3rd story) locations about 6 feet from the building locations on the sides or at the corners facing the street, and at ground and elevated locations at more distant locations further into the site. The results of this mitigation modeling are discussed below for each of the four segments of the northern portion of the site.

West End

Modeling indicates future sound levels without mitigation at the ground-level outdoor use area in this portion of the site would be in the range of 74-75 dBA L_{dn}. Day-night sound levels at elevated locations at the building setback would be about the same (i.e., 74-75 dBA L_{dn}). Sounds levels in the park area near 8th Avenue also would also be in this range. A 6-foot noise barrier along the top of the rockery would reduce ground-level sound levels in this portion of the site to at or below the 65-dBA HUD noise criteria. Such a barrier would be considered both effective in reducing noise and cost-effective under WSDOT noise mitigation criteria. However, it would also create a physical

barrier, would raise security concerns and would not meet HUD's HOPE VI program goal to integrate Greenbridge into the surrounding community.

A 6-foot barrier also would reduce noise at ground-level locations at the building setback in this area, which would preclude the need for special building materials and techniques to reduce interior sound levels as required by HUD noise criteria. This barrier would not, however, reduce sound levels at the second and third story levels in these buildings, so traffic noise levels would be considered "normally unacceptable " under HUD criteria. With predicted sound levels of up to 75 dBA L_{dn}, it will also be necessary to use building construction techniques and materials to provide at least 30 dBA of reduction in exterior sound levels. Noise-reducing construction will be required for the northern, eastern, and western walls of buildings in this portion of the site. With a 6-foot barrier in place, only the second and third floors would require such treatments; without a barrier, the ground floor also would need to be treated to reduce noise infiltration.

Because of the existing high terrain on the west end of the site, a relatively short noise barrier could be very effective in shielding a fairly large outdoor use area and the first story of residential buildings from noise from SW Roxbury Street. Acoustical construction would also be necessary to protect the interior spaces on upper floors. Both these noise mitigation methods are recommended for the west end of the project site.

To be effective, a noise barrier must be solid from the ground to the top, and must remain solid in perpetuity. A barrier must be constructed of sufficiently dense material to prevent noise from passing through it, and must be tall enough to break the line of sight between the noise sources and the shielded receiving locations. Thick wood (with a mass of at least 4 pounds/square foot) can suffice for noise barriers, but wood must be treated and maintained to ensure the barrier remains solid over its life. Although the initial costs are usually somewhat higher, some form of masonry walls would also be effective barriers because they block more sound and have lower life-cycle costs.

The park area just west of the site entry on 8th Avenue would not be shielded by this noise barrier, so sound levels would exceed the HUD limits for outdoor use areas where quiet is a basis for use. Consequently, planned uses of this park should not include activities that require easily understood conversation (e.g., instructional classes), focused concentration (e.g., reading), or relaxation. From a design perspective, physically separating this park from the neighborhood would be contrary to HUD's HOPE VI program goals and the objective of integrating Greenbridge into the surrounding community. It could also raise security concerns. Most Greenbridge parks have been planned and located in interior portions of the site, away from traffic noise.

Center Block

Modeling indicates future sound levels without mitigation at the ground-level building setback in this portion of the site would be in the range of 72-73 dBA L_{dn}. Closer to the road on the narrow lawn, sound levels would be higher. A 6-foot noise barrier at the edge of the sidewalk and across the entire frontage of this building would reduce ground level sound levels in this portion of the site to at or slightly above the 65-dBA HUD noise criteria. Although such a barrier would be technically considered both effective in reducing noise and cost-effective under WSDOT noise mitigation criteria, the outdoor area protected by such a barrier would be too small and located on a sloped area and would not provide much in the way of an outdoor use area.

Although a noise barrier would reduce noise at ground-level locations at the building setback, it would require at least an 8-foot barrier to provide sufficient reduction to preclude the need for special building materials and techniques along the first floor of the north face of the building to reduce interior sound levels as required by HUD noise criteria. Noise walls of this height would also create a substantial physical barrier between Greenbridge and the surrounding community and would create security concerns. This separation would conflict with the HOPE VI program goal of achieving physical integration.

Any reasonable sized noise barrier would not, however, reduce sound levels at the north side second and third story levels in these buildings or the eastern and western ends of the building, including the ground floor. Consequently, traffic noise levels would be "normally unacceptable" under HUD criteria, and it will be necessary to use building construction techniques and materials to provide at least 30 dBA of reduction in exterior sound levels. Noise-reducing construction will be required for the northern, eastern, and western walls of the single block building in this portion of the site.

Because the portion of the project site between the center block building and SW Roxbury Street is at grade with the road and relatively small for an outdoor use area, using a noise barrier to shield this area of the site is not recommended. Instead, the focus in this area should be on using acoustical construction techniques to ensure that interior sound levels are suitable for healthy human habitation.

Noise modeling indicates the area on the south side of this building would be sufficiently protected from traffic noise by the building to result in sound levels that are "acceptable" according to the HUD noise criteria. Therefore, the south side of the building would be suitable for an outdoor use area.

Center Hill

In the center hill area of the north portion of the project site the estimated future day-night sound levels at ground level at building setback range from 66 to 71 dBA, and third story levels range from 71 to 73 dBA. These projected levels would be considered "normally unacceptable" according to the HUD noise criteria. Modeling indicates it would require an 8-foot barrier along the top of the rockery to provide sufficient noise reduction to be considered technically effective at reducing noise and cost effective under WSDOT policy. An 8-foot barrier would not effectively shield the small potential outdoor use area atop the hill because this area is higher than the surrounding area. And although an 8-foot barrier would shield the first level of buildings homes in this area, it would not shield the upper stories. Thus, it will be necessary to use building construction techniques and materials to provide at least 28 dBA of reduction in exterior sound levels for the northern, eastern, and western walls of the two northernmost buildings in this area of the site.

Because it would require a fairly tall wall to provide effective noise mitigation for a limited outdoor use area, it is likely that any barrier would also block views to the east from this area of the site. And due to the terrain in this area, any reasonably sized barrier would not be very effective. Also, creating a physical barrier would create security issues and would conflict with HUD's HOPE VI program goal of integrating Greenbridge into the surrounding community For these reasons, a noise barrier is not recommended in this area, and the focus should be on acoustical construction as described above.

It will be necessary to provide some form of fencing for safety reasons to block the drop to the sidewalk level from the top of the rockery in this area. This could be accomplished with lightweight

fencing that does not need to meet the standards of density and durability of a noise barrier; as noted previously, any such barrier would not reduce noise effectively.

It might also be possible to use site planning techniques to reorient the northern-most building(s) further to the east to act as a barrier for the adjacent outdoor use area.

East End

On the east end of the north portion of the project site the estimated future day-night sound levels at ground level at building setback range from 71 to 73 dBA, and projected third story levels are 74 dBA. Levels up to 74 dBA are expected closer to the road in what could be an outdoor use area. These projected levels exceed the HUD noise criteria. Modeling indicates that a 6-foot barrier near the back of the sidewalk would provide sufficient noise reduction at ground-level locations to be technically considered effective at reducing noise and cost effective under WSDOT policy. However, noise walls would conflict with HUD's HOPE VI program goal to physically integrate Greenbridge into the surrounding community. They would also raise security issues.

Although a 6-foot barrier would shield the first level of homes in this area, it would not shield the upper stories. Because the outdoor use area that would be shielded by this barrier would probably be of marginal utility because of its size and location, a noise barrier is not recommended for this portion of the site. Thus, it will be necessary to use building construction techniques and materials to provide at least 29 dBA of reduction in exterior sound levels for the northern, eastern, and western walls of all buildings in this portion of the site.

Sound levels in the park area on the east end of the site near 4th Avenue would exceed the HUD criteria for outdoor use areas where quiet is a basis for use. Consequently, planned uses of this park should not include activities that require easily understood conversation (e.g., instructional classes), focused concentration (e.g., reading), or relaxation.

Site Planning/Outdoor Residential Use Area

Changes to the site layout and building orientations to shield portions of the site could reduce noise at both interior and exterior locations. Orienting portions of the site plan so outdoor use areas are located south of the residential buildings along SW Roxbury Street would reduce noise levels outside. These residential buildings would effectively act as noise barriers between SW Roxbury Street and the outdoor receivers. The horse-shoe shaped building in the Center Block area is an example -- the outdoor use area south of the building would be shielded from traffic noise. Some further adjustments to building and outdoor space locations and orientation could be considered. For example, the previous discussion has identified the Center Hill area as one where building orientation could potentially be adjusted used to further shield outdoor space from traffic noise. Master planning has located most on-site parks in interior portions of the site, away from off-site traffic noise.

Exterior to Interior Noise Reduction – Construction Methods

In order to meet HUD requirements for interior sound levels suitable for sensitive residential uses it will be necessary to provide from 28 to 30 dBA of reduction in exterior sound levels. Normal construction materials and techniques can provide about 15-25 dBA reductions in exterior to interior sound levels if there are no openings like windows, doors, or ventilation ports on the noise-affected sides of the buildings. Open windows reduce the sound-blocking properties of a wall by at least

50 percent. Thus, it will be necessary to employ special designs, materials, and construction techniques to insure that interior sound levels in the residential buildings fronting on SW Roxbury Street comply with HUD suitability standards.

Based on building code construction requirements, indoor sound levels in most areas of the site would likely be reduced to the point they would not exceed HUD suitability criteria. However, in areas fronting on SW Roxbury Street, additional noise reduction using special building techniques and materials will be necessary. There are a variety of methods and materials that could be used to provide the required noise reduction. For example, building wall designs that include dense sheeting materials, tightly sealed acoustic windows and doors to limit sound penetration, and/or sound-absorbing insulation material for the north, west, and east sides of units adjacent to SW Roxbury would ensure noise levels inside these units remain below HUD criteria. Specially designed ventilation ports or ducts, and/or some form of active ventilation system so that it would not be necessary to open windows or doors to provide ventilation, could also be considered. The master plan's solar design and orientation would help limit the need to open windows for ventilation to the warmest months of the year. Although HUD considers the use of acoustical construction techniques without also taking steps to reduce outdoor sound levels as the least desirable mitigation option, protecting interior levels to provide a suitable indoor living environment is the most important aspect of the HUD noise control program. The design specifications also should include requirements for tight seals, and use of acoustical caulk around all partition openings. The details of the noise control building designs would be worked out during later phases of project design.

4.7.4 Significant Unavoidable Adverse Impacts

No significant unavoidable adverse noise impacts are anticipated to result from the project. However, noise control measures would be required to reduce existing and anticipated future traffic noise to levels suitable for residential uses under HUD criteria.